

Original citation:

Barnes, Sally-Anne, Brown, Alan and Warhurst, Christopher (2016) Education as the underpinning system : understanding the propensity for learning across the lifetime (Future of Skills & Lifelong Learning Evidence Review). London: Foresight, Government Office for Science. (Foresight, Government Office for Science).

Permanent WRAP URL:

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Education as the Underpinning System: Understanding the propensity for learning across the lifetime

**Future of Skills & Lifelong Learning
Evidence Review**

Foresight, Government Office for Science

Education as the Underpinning System: Understanding the propensity for learning across the lifetime

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26 September 2016

This review has been commissioned as part of the UK government's Foresight Future of Skills and Lifelong Learning project. The views expressed do not represent policy of any government or organisation.

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Executive summary

There is much debate about how the labour market responds to changes, for example technological and demographic. Within this context, the support from the education and skills system still has a role in supporting individuals to make important decisions about their engagement in education and investment in skills, as well as helping individuals make informed choices and decisions about their transitions into and through the labour market. Individuals need to continuously adapt their skills and competencies whilst acquiring new and/or specialist skills to cope with demographic and labour market shifts. This is achieved by engaging with learning across the lifecourse.

Recent frameworks for understanding the lifecourse, such as career adaptability, have focused on the attributes and competences needed of individuals to manage these labour market changes and transitions that they now face during their life. These frameworks take account of individual's engagement in learning throughout their life and how career and life decisions might be made. Career adaptability is viewed as necessary to build career resilience and career management as well as offering a fresh perspective on the challenges and opportunities presented by the changing labour market. If the education and skills system is to further affect an individual's resilience then it needs to encourage and support the development of career adaptability attributes and behaviours across the lifecourse.

The benefits of engaging with education and learning across the lifecourse is that it enables people to: up-skill for a particular career path; reskill for a career change; catch up on learning; respond to changing circumstances; remain in the labour market longer; be productive; and engage in further learning (see section 4). Importantly, those engaged in learning are more likely to remain in the labour market and are better able to cope with change and multiple transitions (see section 7).

Policies should be aimed at helping individuals develop, maintain and improve their learning and skills to support an extended working life. This aim could be achieved through the provision of personalised and tailored skills development programmes, which could be delivered within educational institutions, workplaces or online, all underpinned by the provision of effective careers guidance throughout the lifecourse and the support for individual engagement with learning, in all forms, across the lifecourse. The outcome will be a system that facilitates a workforce that is more resilient and better able to manage and positively respond to labour market – and other – changes.

I. Introduction

In the context of labour market changes and other shifts, individuals have become responsible for their learning across the lifecourse and increasingly bear the costs and risks of learning (see Bimrose et al., 2016; Hughes, Adriaanse and Barnes, 2016; Schmid, 2016). This paper reviews evidence on how the education and skills system affect an individual's resilience to demographic and labour market shifts. It considers the skills, competences and attributes individuals need in order to adapt to these shifts and how this adaption can be developed by engaging with learning across the lifecourse. Recent frameworks for understanding the lifecourse that have focused on the skills, attributes and competences to cope and manage with the unstable and changing labour market will be used.

Throughout their lifecourse, individuals make important decisions about their engagement in education, investment in skills and their participation in the labour market. Whether these individuals are in transition from education and/or training, in employment and wishing to up-skill, re-skill or change their career direction or whether they are outside the labour market wishing to re-enter it, the education and skills system can play an important role in supporting those individuals given the right development and innovation.

Learning, planned and unplanned, formal and informal, inside and outside the workplace, has become a key mechanism and process in navigating the changing labour market and the transitioning work over the lifecourse. The changes and transitions may occur through choice or constraints. Both may have implications for individuals' attitudes towards and experiences and coping with learning over the lifecourse (Glastra, Hake and Schedler, 2004).

In order to respond to demographic and labour market shifts, individuals need to be able to continually develop skills, competences and attributes with support from the education and skills system. The low skilled are susceptible to these shifts as they may not have the resources to respond or understand occupational choices and complex occupational pathways. Individuals need to develop career resilience and manage their careers in order to respond to the changing demands of employment and the multiple job transitions they will experience during their working life. Part of these skills, competencies and attributes centre on flexibility, being ready, maintaining employability and creating opportunities (Fouad and Bynner, 2008; Savickas et al., 2009).

The education and skills system can play a significant role in supporting individuals throughout their lifecourse to develop skills and knowledge and maintain a productive workforce, which in turn creates sustainable long-term economic growth in the labour market. Education and skills are considered important 'in enabling people to maximise the opportunities available to them, achieve their potential and make a contribution to the country's economy' (Macrory, 2016). It is evident that education and skills are important to both the individual and the economy. The UK Human Capital stock, measuring the value of knowledge, skills, abilities, social attributes, personalities and health attributes acquired during participation in formal education and their value in the labour market was estimated to be £18.95 trillion in 2014 (ONS). Over the last two decades, the percentage of the population (aged 16-64 years) with higher-level qualifications

has continued to increase with the majority of workers in 2024 expected to be qualified to Level 4 or above (Wilson et al., 2016). The percentage of the population with no qualifications has not changed over recent years and in 2015 was 8.6% (Labour Force Survey, ONS) and is forecast to decrease to 2024 (Wilson et al., 2016).

This review provides an overview of the contextual shifts that affect individuals' work-orientated learning over the lifecourse. An overview of that context is presented next. This section is followed by a presentation of the evidence on career development. The opportunities and constraints to learning and skills development across the lifecourse are then presented. The review then turns to evidence on skills, competences and the attributes needed across the lifecourse. It will then consider recent frameworks for understanding the lifecourse, which have focused on unstable and changing labour markets. As part of the conclusion, the role of the education and skills system in affecting an individual's career resilience to demographic and labour market shifts will be considered.

2. Context and trends: Demographic and labour market shifts

With recent labour market and other changes, the education and skills system now operates in a complex and evolving context. It has to respond to these changes, which represent both opportunities and challenges to individuals. In order to cope and adapt, these individuals need a range of skills, competencies and attributes.

A number of recent studies have outlined and discussed current labour market shifts and related demographic and social, technological and global shifts (see Eurofound, 2015; OECD, 2016a; OECD, 2016c; OECD, 2015b; Paccagnella, 2016; Störmer et al., 2014; UKCES, 2016; Wilson et al., 2016). If the death of the job for life was once the salient issue (Fouad and Bynner, 2008), more recently attention has turned to the potential widespread eradication of jobs through automation (Frey and Osborne, 2013) and even the dissolving of employment with the emergent platform economy (Warhurst et al., 2016). Table 1 provides an overview of these changes and shifts and how they impact the education and skills system in the UK.

These changes and shifts impact individuals in a number of ways and require a response from the education and skills system. In particular, now bearing the responsibility and risk associated with learning over the lifecourse, individuals need to continuously adapt their existing skills and competencies whilst also acquire new and/or specialist skills. This adaption, however, is only part of the story; individuals also need to be resilient and flexible to compete in a changing, unstable labour market in a global economy. For the UK economy to sustain productivity levels, a highly skilled workforce that can innovate and adapt to change is needed (Paccagnella, 2016). This evidence suggests that greater investment in education and skills is needed. Whilst individuals have increased responsibility, support for this investment also needs to come from the education and skills system (see Brown, Bimrose, Barnes, Kirpal, Grønning and Dæhlen, 2010; Hughes, Adriaanse and Barnes, 2016).

Table 1 Overview of demographic and labour market shifts

 Demographic and societal shifts and trends	 Labour market shifts and trends
<ul style="list-style-type: none"> □ Growing diversity of population and labour force in terms of gender and ethnicity □ Increasing migration □ Ageing population, more of whom are working in later life and remaining economically active past retirement □ Growing inequity between the high and low skilled, high and low qualified □ Expectations that young people will remain in education and training longer and have work experience and higher qualifications □ Participation in education is expected to remain high increasing the supply of skills to the labour market 	<ul style="list-style-type: none"> □ Unstable labour markets impacting on companies, sectors and economies □ Continued shift from manufacturing to services requiring new skills and knowledge □ Reconfiguration of organisations with outsourcing and internationalisation of labour market, ICT-based work □ Reconfiguration of work and employment with task-based platform economy □ Increased non-standard employment and need for flexibility and unconventional work patterns and workplaces □ New and emerging occupations □ Shifts in job quality, variations of polarisation by pay and skill □ Average qualification level to rise within all occupations; majority of workforce expected to have Level 4 and above qualifications
 Technological shifts and trends	 Global shifts and trends
<ul style="list-style-type: none"> □ Rapid and constant technological developments and innovations requiring new skills, knowledge and competencies □ Technological developments providing new opportunities for education and work □ Converging technologies requiring cross-disciplinary skills and knowledge □ Technology enabling greater access to information, supporting information sharing and exchange □ Greater digital divide between those with digital skills and IT access, and those who have no or limited skills and access 	<ul style="list-style-type: none"> □ Global competition in terms of innovation, productivity and labour □ Increasing globalisation invading all aspects of public, private and work life □ Increasing global networked talent pool, which is expected to continue growing over the next few decades □ Emerging economies contributing more to the global economy in terms of the labour pool and productivity □ Continued rise in international trade, spread of multi-national companies and greater financial integration

Sources: de Hoyos et al., 2013; Eurofound, 2015; Huws, 2015; OECD, 2016a; OECD, 2016c; OECD, 2015b; Paccagnella, 2016; Störmer et al., 2014; UKCES, 2016; Warhurst et al., 2016; Wilson et al., 2016

3. Life and career development

Current evidence highlights the importance of individual competencies, behaviours and attitudes in managing change and shifts in the labour market with a focus on flexibility, adaptability and lifelong learning. Recent models take account of individuals' engagement in learning throughout their working life and how individuals' characteristics and context influence career and life decisions.

To consider how the education and skills system can respond to these shifts, there is a need to understand how individuals' careers develop over the lifecourse.

Life and career development stages approach takes account of an individual's self-concept changing over time and influencing career choices. Whilst Super's Life Span approach (Super, 1957) or career development model can be considered dated, it is useful when considering the evidence presented on those early in their career. The model recognises five stages of career: growth; exploration; establishment; maintenance; disengagement. There are different needs at each career stage. For instance, during the growth stage individuals are trying out their skills, testing out different types of occupational roles and engaged in skills development, and so need additional support and mentoring. By contrast, during the establishment stage, individuals are building their careers and attaining stabilisation, and so need opportunities for career development (see Super, 1957).

Others suggest that individual capability for decision-making differs and changes over time, such as proponents of cognitive information processing (see Peterson et al., 2002) and Social Learning Theory of Career Decision-Making (SLTCDM) (Krumboltz and Nicholas, 1990). A cognitive information processing approach takes account of the complexity of individual circumstances as a key factor in the decision making process. These decisions are thought to be founded on self and occupational knowledge, comprising values, interests, skills, employment preferences and knowledge of options. This approach can offer a way to understand how and why career and life stages can change individual priorities and employment preferences. Alternatively, SLTCDM states that career choices and decisions should be the result of learning as an interaction with environment and genetic endowment (i.e. personal characteristics and abilities). Others recognise that both individuals and environments change (Osipow and Fitzgerald, 1996) and more recent theories of careers guidance practice substantiate the importance of individual competencies in managing change (e.g. Patton and McMahon, 2014; Savickas and Porfeli, 2012).

Whilst theories from Super (1957), Holland (1992), Krumboltz and Nicholas (1990), Osipow and Fitzgerald (1996) and Peterson and colleagues (2002) offer understanding of career stages and factors in the occupational choice decision making process, more recent frameworks for understanding careers have focused on the unstable and changing labour market (see Savickas et al., 2009). Recent frameworks and models recognise differences between individuals in terms of their characteristics and context, as well as focusing on empowerment through work and work relationships (see Mitchell and Krumboltz, 1996; Patton and McMahon, 2014; Schultheiss, 2003). Savickas and colleagues (2009) present the life design approach, which

adapts individual understanding to different time frames. Life design interventions allow career guidance professionals to support clients in constructing their career through small stories, reconstructing the stories into a life portrait, and co-constructing intentions that advance the career story into a new episode. Recent theoretical models of careers, therefore, focus on flexibility, adaptability and lifelong learning. Evidence from the UK on how models can support the skills system may be found in a report commissioned by the UK Commission for Employment and Skills (see Bimrose, Brown, Barnes and Hughes, 2011).

4. Encouraging learning and skill development across the lifecourse

Whilst there has been a shift in focus to reskilling, developing new skills and updating existing ones, evidence suggests learning is often undertaken for a particular career path or career change. All types of learning across the life course is reported to be beneficial as enables individuals to respond to changing circumstances and cope with change and transitions throughout their life.

Recently, lifelong learning policy has shifted its focus from skill development in relation to up-skilling to emphasising the importance of reskilling, developing new skills and updating existing ones. With this shift, there is a growing trend for individuals to engage with formal education and training throughout their working life. Recent research, with adult learners in England, reported that learning across the lifecourse is beneficial as this enables people to ‘catch up on learning’ and, in some instances, raise their basic skills proficiency, respond to changing circumstances, meet new people and cope with change and transitions throughout their life (Hughes et al., 2016). Indeed, individuals report feeling reinvigorated, more willing to remain in the labour market and to want to engage in further learning (Brown and Bimrose, 2011; Brown et al., 2010; Hughes et al., 2016). It should be noted too that older individuals are engaged in learning and development activities (see Brown et al., 2010; Brown and Bimrose, 2011; Green, 2009).

However, research also shows that it is more common for individuals to engage with intensive periods of learning across the lifecourse than to do so regularly and incrementally across the lifecourse (Brown et al., 2010). This intensive learning is often related to up-skilling along a particular career path and reskilling for a career change. Indeed, further research reveals that those who engage in learning are more likely to use their learning to change career. Where learning is undertaken in a variety of contexts, this has found to encourage mid-career transitions (Brown, 2015a; Fuller, 2007).

Support to assist individuals in their continued investment in their skills and education is particularly important for those individuals wishing to raise their basic skills proficiency levels. The need for careers guidance to support multiple transitions over the lifecourse and meet changing labour market demand and supply is emphasised both for the UK and internationally (e.g. Council of the European Union, 2004; OECD, 2004).

Individuals can also be encouraged to invest in their skills and improve their educational attainment levels by providing opportunities to develop at work. Skills development at work is argued to support effective development of intermediate skills and improve organisational performance and national productivity (Brown, 2009) and is achievable when linked to industry business strategies and, within organisations, supportive management (Ashton et al., 2016). In this respect, investment in skills and thereby skills development at work requires organisations to have a culture that facilitates and supports learning for individuals early and later in their career (Eraut et al., 2007; Fuller and Unwin, 2006).

Learning and skills development at work for those at all stages of the lifecourse can be realised through a range of formal and informal activities, such as apprenticeships, learning on-the-job, work shadowing and mentoring. Considerations for assisting skills development at work include:

- Enabling opportunities for engagement with challenging work;
- Supporting the learning and development of others; and
- Encouraging interactions at work through learning while working (Brown et al., 2010).

Research has suggested that enabling opportunities to engage in challenging work, that is work requiring a combination of tasks and duties and the application of a higher level of skills, encourages individual investment in skill development (Bimrose et al., 2011; Brown, 2009; Brown et al., 2010; Eraut et al., 2007; Felstead et al., 2008). Part of this process is also about how well individuals are supported in their learning and development, which can be through a combination of support mechanisms. These include: mentoring; supervisory support; formative feedback; and reviews of strengths and weaknesses (Eraut et al., 2007; Brown, 2009). These processes can then provide opportunities to identify further learning and encourage self-directed learning that can also lead to individual investment in skills. Others suggest that by providing flexible working conditions individuals are able to combine work and education, but bridging mechanisms (such as training allowances) may also be needed (Schmid, 2016).

Recent research across Europe has, however, identified a number of important considerations when developing policy and practice to support skills development at work (Ashton et al., 2016; Bimrose et al., 2016; Brown, 2009; Brown, et al., 2010; CEDEFOP/Brown, Bimrose and Merrill, 2014). First, as we have already noted, skills development policy should focus on enhancing both individual development and organisational performance. Second, individual learners need to be actively engaged in the process of skill development and receive feedback from management. Third, effective skills development at work should be founded upon acknowledgment of an individuals' prior experience and learning and also engage with the expertise and knowledge that underpins these individuals' work. Fourth and relatedly, higher and continuing education can allow individuals to engage with valued forms of knowledge, and how this knowledge may be linked to the introduction or development of particular careers. Fifth, evidence of the ability to engage effectively with a complex knowledge base may itself have value on the labour market as a signalling mechanism to employers of individuals' possession of the capability to handle changes in knowledge bases underpinning different types of work (Tholen et al., 2016).

Overall, skills development at work will encourage individuals to invest in their skills and educational attainment levels if the learning fits with an individual's broader career plans and these plans are embedded within broader interests.

5. Opportunities, barriers and constraints

Opportunity structures for transitions throughout the life course are important. Widening those structures encourages individual aspirations, occupational mobility and participation in education and training. Parental socio-economic class, status and education impact on an individual's educational attainment and willingness to engage in education and learning across the life course. The education and skills system needs to address any negative impacts by providing personalised and context sensitive careers guidance throughout the life course.

A range of research on labour market transitions and career trajectories reports the importance of opportunity structures for transitions from education to employment, for career development throughout the lifecourse (e.g. Brown et al., 2010; Roberts, 2007). Widening opportunity structures are seen as useful in encouraging individual aspirations, occupational mobility and participation in education and training. Opportunity structures can be defined through the principles of 'flexicurity', including lifelong learning strategies, effective active labour market policies, mobility and recognition in the importance of up-skilling (Brown et al., 2010). Without these structures in place, encouraging individuals to engage in a process of skills development can be challenging.

It should also be noted that barriers and constraints also exist and impede individual progress (Bimrose et al., 2008; Bimrose et al., 2016; Brown et al., 2010). For instance:

- Funding support may be unavailable to help with education or training costs;
- Childcare is often not available (or not affordable) to support caregivers engaging with the demands of training;
- Transport can be a problem, especially in rural areas;
- Chronic, long-term ill-health often prevents engagement with training and labour market opportunities; or
- Broader care responsibilities (for elderly parents) restrict choices.

Research also highlight the influence of parental socio-economic background and education on, as well as predicting, an individual's educational attainment and willingness to engage in education and learning later in life (Bimrose et al., 2016; Bukodi and Goldthorpe, 2013; Bukodi et al., 2013). Parental socio-economic background and parenting style influence child development and educational aspirations (Ebner, 2008) and parental educational aspirations and knowledge influences children's education success and pathway (Haunberg and Teubner, 2008). Significantly, low skilled and low qualified adults are more likely to have had poor experiences of education and low educational attainment (Bimrose et al., 2016). Consequently, this group were less likely to continue their education or engage in further education in later life. Importantly, this study also found that those who had engaged in learning and had progressed in the labour market had received personalised support (Barnes and Brown, 2016) or context sensitive career guidance (Bimrose, Mulvey and Brown, 2016). Socio-economic background is

thus an important factor in determining educational attainments, engagement with education and available opportunities at all ages.

6. Skills, competences and attributes for the lifecourse

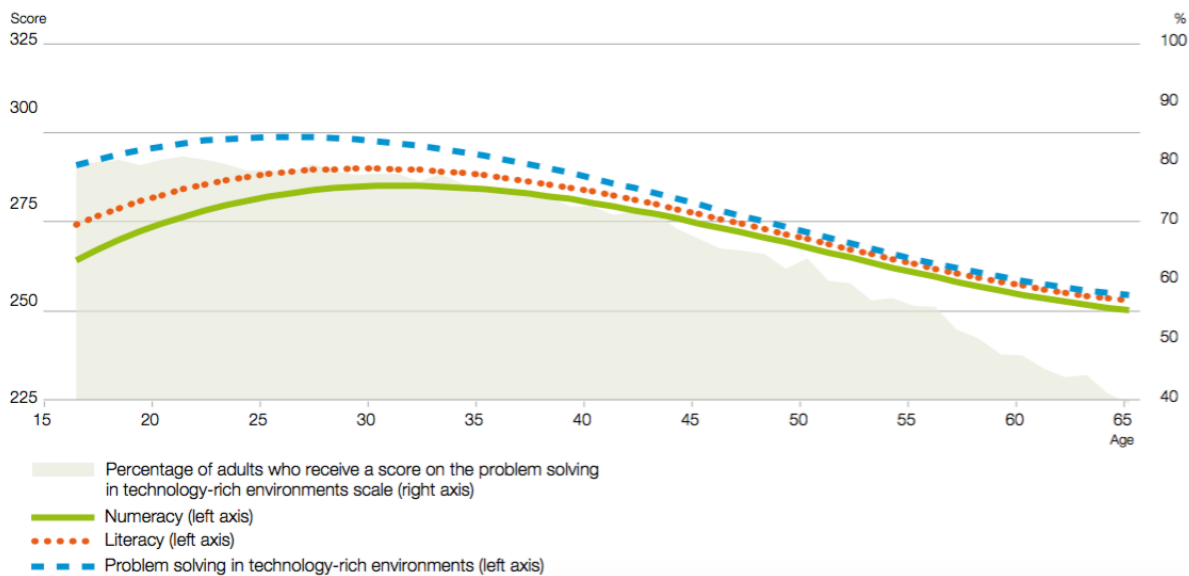
A range of cognitive and non-cognitive skills need to be learnt and utilised throughout the life course in order to cope and manage the changing labour market. Development of these skills early on in life is a strong predictor of employment and higher wages. Evidence highlights the importance of early education experiences and the educational environment in creating positive outcomes for individuals across the life course.

It is widely accepted that there are a number of key skills that need to be learnt and utilised during the lifecourse and which often form the basis of employability frameworks, including literacy, numeracy, problem-solving in technology rich environments and digital skills (see for example Dacre Pool and Sewell, 2007; McQuaid and Lindsay, 2005). These skills are important, as they are strong predictors of employment and higher wages (average wages are 10% or more for those with key skills in England) (OECD, 2016b).

Socio-demographic differences (e.g. age, immigrant background, education level, parents' educational attainment) can negatively impact on skills proficiency, whilst differences in skills proficiency by gender are negligible. The Survey of Adult Skills undertaken as part of The Programme for the International Assessment of Adult Competences (PIACC) found that individuals' skill proficiency level (in terms of numeracy, literacy and problem solving) is positively influenced by a parent with a higher level of qualification. In addition, workers with an immigrant background were more likely to have low skills proficiency (OECD, 2016b). The PIACC survey also found differences in skills proficiencies between those workers aged 25-34 years and 44-65 years, with older adults being less proficient (Paccagnella, 2016) (see Figure 1 below). There is a 10 percentage point difference between those aged 16-24 years and those aged 25-34 years (OECD, 2016b). Whilst labour outcomes and wages for older adults are approximately equivalent, if not better than younger adults, the evidence suggests that skills policies are not addressing skills development over the lifecourse.

Encouraging investment in education and skills development programmes, particularly for older workers, is key to supporting those who wish to remain in work later in life. Those that engage in education and learning throughout the working life to develop and maintain their skills are more likely to stay in work longer, be productive and progress in their careers (Bimrose, Barnes and Hughes, 2008; Brown, 2009; Brown et al., 2010; Paccagnella, 2016). Others have suggested that for older workers it is not just about having the skills but also about ensuring that work is suitable and employers provide training (Lorretto, Phillipson and Vickerstaff, 2016; Schmid, 2016).

Figure 1: Age profile of skills proficiency



Source: Survey of Adult Skills (PIAAC) (OECD, 2012)

Digital skills are increasingly important underpinning the UK economy (Ecorys UK, 2016; OECD 2015a). As technology progresses, these skills need to be continuously developed in order for the economy to remain competitive and innovative. Recent research suggests that basic digital literacy skills are needed by all and need to be used in the workplace to be of benefit to the individual and the economy (van Deursen and van Dijk, 2010). For those engaged in the platform or task-based economy, these skills are particularly important (Barnes, Green and de Hoyos, 2015).

Working adults need a minimum set of digital skills that can be applicable to a range of sectors, plus specific skills that depend on role and sector (Ecorys UK, 2016). Evidence from the PIAAC survey shows that those with digital skills are more likely to be participating in the labour market compared to those low level digital skills even after accounting for other factors (e.g. age, gender, level of education, literacy and numeracy proficiency) (OECD, 2016b). In England, Northern Ireland and Ireland, participation rates of adults working at Level 2 or 3 is 17 percentage points higher than those at or below Level 1. This rate is similar to those across Europe. In England, there is a wage premium for using ICT skills and ICT experience (OECD 2015a).

Longitudinal research, using the British Cohort Study, indicates that education attainment is linked to wage premiums and that non-cognitive factors have a modest effect on pay later in life (Green et al., 2015). However, others have reported that non-cognitive skills, behaviours and attitudes (e.g. motivation, perseverance and self-control) can be predictors of economic and social success. Heckman and colleagues (2006) suggest that these non-cognitive skills are more important than cognitive skills in determining, for example, variances in wages, acquisition of skills and productivity in the labour market. A recent review suggests that the development of non-cognitive skills leads to positive academic outcomes and financial stability in adulthood (Morrison Gutman and Schoon, 2013). This research shows that there are gaps in the understanding of how to develop non-cognitive skills. Nonetheless there is strong evidence that

these skills are developed within schools with effective teaching and social and emotional learning (SEL) programmes (for more detail on SEL programmes see section 4.4 of Morrison Gutman and Schoon (2013)).

Overall, this research highlights the importance of early education experiences and the educational environment in creating positive outcomes for individuals. Poor experiences can have a long-term negative impact on individual engaging with learning across the lifecourse.

7. Managing and coping with change

Frameworks and models for understanding the life course have focused on the changing labour market as well as the differences between individuals, their life stage and their context. These approaches focus on advocating individual career resilience, adaptability and lifelong learning in order to manage and cope with change.

A number of currently accepted frameworks and models for understanding the lifecourse have focused on the unstable and changing labour market. These frameworks skip the reasons for the increasing individualisation of learning responsibility over the lifecourse and instead take as their starting point the existence of this responsibility in the context of changed labour markets. Many also recognise differences between individuals in terms of their characteristics as well as focusing on empowerment through work and work relationships (see Mitchell and Krumboltz, 1996; Patton and McMahon, 2014). As noted earlier recent theoretical models of careers focus on career resilience, adaptability and lifelong learning. These models take account of individual's engagement in learning throughout their life and how these influence life decisions, as well as taking into account personal changes (e.g. starting a family, getting a divorce, taking care of elders etc.).

London and Noe (1997) define career resilience as 'the ability to adapt to changing circumstances even when the circumstances are discouraging or disruptive. It consists of such variables as belief in oneself, need for achievement, and willingness to take risks' (p. 62). Career resilience is promoted by 'protective factors or developmental assets' which individuals can use to cope and manage change (Bimrose and Hearne, 2012, p.339). Some research has demonstrated the positive impact of developing and promoting resilience with young people (Yeager and Dweck, 2012) and adults (Bimrose and Hearne, 2012). Research on graduates found that skill resilience can be acquired formally and informally and in a multitude of different situations: family, school, peers, college, university, workplace etc. (Tholen et al., 2016).

Career adaptability can be seen as necessary to building career resilience and managing careers and life in a shifting labour market. As a model, career adaptability (Savickas et al., 2009) seeks to accommodate a changing environment where occupational prospects are unclear and job transitions are becoming more frequent and difficult. UK research found that career adaptability is needed in order to make successful transitions in a labour market where occupational and organisational knowledge bases can rapidly change (Bimrose et al., 2011). One predictor of career adaptability is the propensity of individuals to learn and develop their competences (Creed et al., 2009) and one of the most powerful ways individuals become engaged with learning is through challenging work (Brown, 2009), from that point career adaptability is also developed (Brown, 2015b),

Coming from the perspective of work psychology Fouad (2007) defined career adaptability as an individual having the necessary resources and being ready to undertake career-related tasks. These resources can be cognitive (e.g. knowledge and decision making skills), social (e.g. the support of others) and psychological (e.g. emotional readiness). Conceptualisation of career adaptability has been further developed from a psychosocial perspective (Savickas,

1997; Savickas et al., 2009; Savickas and Porfeli, 2012). With this development, career adaptability now refers to an 'individual's readiness and resources for coping with current and anticipated tasks, transitions, traumas in their occupational roles' (Savickas and Porfeli, 2012). Table 2 below provides a summary of the dimensions of career adaptability, attitudes and competences.

Table 2 Dimensions, attitudes and competencies of career adaptability

Adaptability dimension	Attitudes and beliefs	Competence	Coping behaviours
Concern – developing a positive optimistic attitude to the future	<ul style="list-style-type: none"> Plans Forward thinking Hopeful Connects the present and the future 	<ul style="list-style-type: none"> Planning 	<ul style="list-style-type: none"> Aware Involved Preparing
Control – to use self-regulation strategies to adjust to the needs of different settings and exert some influence and control on the context	<ul style="list-style-type: none"> Decisive Independent Autonomous 	<ul style="list-style-type: none"> Decision-making 	<ul style="list-style-type: none"> Assertive Disciplined Wilful
Curiosity – broadening horizons by exploring social opportunities and possibilities	<ul style="list-style-type: none"> Inquisitive Self-reflective Future focused 	<ul style="list-style-type: none"> Exploring 	<ul style="list-style-type: none"> Experimental Taking risks Inquiring
Confidence – believing in yourself and ability to achieve your goal	<ul style="list-style-type: none"> Efficient Self-confident Self-perceptive 	<ul style="list-style-type: none"> Problem-solving 	<ul style="list-style-type: none"> Persistent Striving Industrious

Source: McMahon, Watson and Bimrose, 2012; Savickas and Porfeli, 2012; Savickas, 2013

To be career adaptable, individuals need the 4Cs of concern, control, curiosity and confidence. These 4Cs lever the continual development of skills and competences (see Table 2) and career management in the context of the changing demands of employment over an individual's working life. Part of these skills and competencies are about flexibility, being ready, maintaining employability and creating opportunities (Fouad, 2007; Fouad and Bynner, 2008; Savickas et al., 2009; Savickas and Porfeli, 2012). Career adaptability therefore involves an individual's capability to negotiate and undertake 'successful' (in the individual's own terms) occupational and labour market transitions in a changing environment and within their own changing circumstances and lives. It is also suggested that this process can be driven proactively by an individual seeking new challenges or wishing to adopt new perspectives. Recent research suggests that certain personality traits and characteristics (e.g. demographic, education, extraversion and future temporal focus) positively change career adaptability over time (Zacher, 2014).

So, across the lifecourse, career adaptability can be seen as necessary to building career resilience and career management as well as offering a new perspective on the challenges and opportunities presented by a changing labour market.

8. The role of the education and skills system

The education and skills system has a vital role to play in equipping individuals with the skills, competences and attributes necessary to cope and manage with labour market and other shifts over their lifecourse.

As the labour market, work and employment are changing, some of the institutions of the old education and skill system (see Crouch, 2006) are in decline (trade unions), have been usurped (the professional bodies) or are being reconfigured (schools, colleges, universities and economic development bodies). Recent reviews (Barnfield, 2013; OECD, 2016a; Störmer et al., 2014) have suggested that in the current context the education and skills system could develop and innovate (see Table 3 below). Table 3 also sets out how these innovations might support individuals in responding to labour market and other shifts over the lifecourse. An innovative and responsive education and skills system, as set out below, can support individuals develop the skills, knowledge, competences, attitudes and behaviours associated with career resilience and adaptability.

Table 3 Education and skills system innovations supporting individuals

Education and skills system needs to:	For individuals:
Develop flexible learning pathways that are more learner centered	To feel control of their learning
Personalise modes of learning and learning content	To feel their learning is relevant to them as an individual
Offer flexible provision (in terms of time and delivery method)	To be able to engage in a way that meets their personal needs, circumstances and preferences
Expand access to education and learning opportunities for academic and vocational training	To be able to engage with learning that meets their learning style/preference
Provide opportunities for people to gain a broad set of skills, knowledge and capacities	Learning will be relevant in the longer term and be applicable to a range of occupations
Support basic skills development through to higher level skills	To be able to progress through the labour market
Take advantage of technological advancements to deliver education and learning	Learning can be innovative, personalised and accessible
Develop a market-based and employer focused curriculum	Learning will be relevant to the labour market
Respond to employer needs and support employers to deliver workplace learning and on-the-job training	Learning will be relevant to occupational role/sector and enable upskilling/reskilling
Offer a variety of qualifications	To be able to engage with learning at a range of levels on a variety of subjects
Support creativity and innovation	Education and skills would feel more relevant, interesting etc.
Provide skills needed for community engagement	Learning could reduce isolation and help individuals embed in local communities

9. Conclusion and policy implications

The education and skills system can affect an individuals' resilience to labour market and other relevant shifts. It has a key role, therefore, in supporting individuals to be prepared for and thrive within these changes.

More specifically, if the education and skills system needs to encourage and support the development of career adaptability attributes and behaviours. This outcome can be achieved by supporting individual engagement with learning across the lifecourse. Career adaptability takes account of individual's engagement in learning and how this influences career and life decisions as well as taking into account personal change. It can be viewed as necessary to building career resilience and career management as well as offering a fresh perspective on the challenges and opportunities presented by the changes to the labour market etc.

The benefits of engaging with education and learning across the lifecourse are clear: it enables individuals to: up-skill for a particular career path; reskill for a career change; catch up on learning; respond to changing circumstances; remain in the labour market longer; be more productive; and engage in further learning. Importantly, individuals engaged in learning are willing to remain in the labour market and are better able to cope with change and transitions. However, it is important that individuals value their learning and recognise how it can be utilised in the labour market. To support this understanding and individual decision-making, impartial career guidance and high quality labour market information is needed to inform education, skill and employment choices. This guidance and information needs to be available to all ages and mandated amongst the key institutions of the emerging education and skills system – schools, colleges, universities, Local Enterprise Partnerships and local authorities etc. – but ensuring integration not duplication of provision.

Workplaces also have a role to play in supporting individuals' response to labour market shifts across the lifecourse. They can encourage and support up-skilling and reskilling of employees to ensure they are up-to-date with current work innovation and technologies. In this respect, there is argument that skill ecosystems are useful in identifying and responding to the mutual and evolving learning needs of individuals and organisations (Anderson and Warhurst, 2012) and evidence from Scotland, Australia and the US suggest that policy might do well to emphasise this ecosystem approach for this purpose (Buchanan, Anderson and Power, 2016).

At the level of the individual, policies should be aimed at helping individuals develop, maintain and improve skills proficiency to support an extended working life. This aim could be achieved through the provision of personalised and tailored skills development programmes, which could be delivered within educational institutions, workplaces or online. By providing individuals with the competencies and attributes to be career adaptable, the system is creating a workforce that is more resilient and better able to manage and positively respond to a changing labour market.

With the right innovation, the education and skills system can play a role in supporting individuals develop and build the career resilience and adaptability. The key message from this review is that, despite, the individualisation of responsibility and risk for learning over the lifecourse, there is still a role for the education and skills system to help individuals navigate

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through their working lives and not just survive but thrive within labour market and other relevant shifts over their lifecourse.

References

- Anderson, P. and Warhurst, C. (2012) Lost in Translation: Skills policy and the shift to skill ecosystems. In Dolphin, T. and Nash, D. (eds.) *Complex New World: Translating new economic thinking into public policy* (pp. 109-120). London: IPPR.
- Ashton, D., Lloyd, C. and Warhurst, C. (2016, forthcoming) Business strategies and skills. In Warhurst, C., Mayhew, K., Finegold, D. and Buchanan, J. (eds). *Oxford Handbook of Skills and Training*. Oxford: Oxford University Press.
- Barnfield, L. (2013) *Rebalancing the UK's Education and Skills System: Transforming capacity for innovation and collaboration*. London: The RSA.
- Barnes, S-A. and Brown, A. (2016) Stories of learning and their significance to future pathways and aspirations. *British Journal of Guidance and Counselling*, 44: 2, 233-242.
- Barnes, S-A., Green, A. and de Hoyos, M. (2015) Crowdsourcing and work: individual factors and circumstances influencing employability. *New Technology, Work and Employment*, 30: 1, 16-31
- Bimrose, J. and Hearne, L. (2012) Resilience and career adaptability: Qualitative studies of adult career counselling. *Journal of Vocational Behaviour*, 81: 3, 338-244.
- Bimrose, J., Barnes, S-A. and Hughes, D. (2008) *Adult career progression and advancement: a five year study of the effectiveness of guidance*. Coventry: Warwick Institute for Employment Research.
- Bimrose, J., Brown, A., Barnes, S-A. and Hughes, D. (2011) *The key role of career adaptability in skills supply: Main report*. London: UK Commission for Employment and Skills.
- Bimrose, J., Brown, A., Barnes, S-A., Thomsen, R., Cort, P., Mariager-Anderson, K., Rochet, S., Mulvey, R., Hansen, B., Weber, P., Weber-Hauser, S., Tomassini, M., Zanazzi, S., Kargul, J., Minta, J., Mielczarek, M. and Sprlak, T. (2016) *Narratives of learning from people in low skilled employment*. Thessaloniki: CEDEFOP.
- Bimrose, J., Mulvey, R. and Brown, A. (2016) Low qualified and low skilled: the need for context sensitive careers support. *British Journal of Guidance and Counselling*, 44: 2, 145-157.
- Brown, A. (2009) *Higher skills development at work: A Commentary by the Teaching and Learning Research Programme*. London: ESRC, TLRP.
- Brown, A. (2015a) Mid-career reframing: the learning and development processes through which individuals seek to effect major career changes. *British Journal of Guidance and Counselling*, 43: 3, 278-291.
- Brown, A. (2015b) Developing career adaptability and innovative capabilities through learning and working in Norway and the United Kingdom. *Journal of the Knowledge Economy*, 6: 2, 402-419.

- Brown, A. and Bimrose, J. (2011) Changing patterns of guidance, learning and careers of older workers in Europe. In CEDEFOP (ed.) Working and ageing: Guidance and counselling for mature learners. Luxembourg: Publications Office of the European Union.
- Brown, A., Bimrose, J., Barnes, S-A., Kirpal, S., Grønning, T. and Dæhlen, M. (2010) Changing patterns of working, learning and career development across Europe (EACEA/2007/07): final report. Brussels: Education, Audiovisual & Culture Executive Agency.
- Brown, A., Rhodes, E. and Carter, R. (2004) Supporting learning in advanced supply systems in the automotive and aerospace industries. In Rainbird, H., Fuller, A. and Munro, A. (eds), Workplace Learning in Context (pp.166-181). London: Routledge.
- Buchanan, J., Anderson, P. and Power, G. (2016, forthcoming) Skill Ecosystems. In Warhurst, C., Mayhew, K., Finegold, D. and Buchanan, J. (eds). Oxford Handbook of Skills and Training. Oxford: Oxford University Press.
- Bukodi, E. and Goldthorpe, J.H. (2013) Decomposing social origins: the effects of parents' class, status and education on the educational attainment of their children. European Sociological Review, 29: 5, 1024-1039.
- Bukodi, E., Erikson, R. and Goldthorpe, J. (2013) The effects of social origins and cognitive ability on educational attainment: Evidence from Britain and Sweden. Barnett Papers in Social Research, 13-04.
- CEDEFOP/Brown, A., Bimrose, J. and Merrill, B. (2014) Navigating difficult waters: learning for career and labour market transitions, Research Paper 42. Thessaloniki: CEDEFOP.
- Creed, P., Fallon, T. and Hood, M. (2009) The relationship between career adaptability, person and situation variables and career concerns in young adults, Journal of Vocational Behavior, 74: 2, 219-229.
- Crouch, C. (2006) Skills formation systems. In Ackroyd, S., Thompson, P. and Tolbert, P.S. (eds.) The Oxford Handbook of Work and Organization (pp. 95-114). Oxford: Oxford University Press.
- Dacre Pool, L. and Sewell, P. (2007) The key to employability: developing a practical model of graduate employability. Education and Training 49, 277-289.
- de Hoyos, M., Green, A., Barnes, S-A., Behle, H., Baldauf, B. and Owen, D. (2013) Literature Review on Employability, Inclusion and ICT, Report 2: ICT and Employability. JRC Technical Report. Luxembourg: Publications Office of the European Union.
- Ebner, S. (2008) Trotzdem erfolgreich? Was prägt die Entwicklung der 10-12 Jährigen mehr – die Soziale Herkunft, die Persönlichkeit oder der Erziehungsstil der Eltern? In Alt, C. (ed.) Kinderleben – Individuelle Entwicklungen in sozialen Kontexten (pp. 181-206). Wiesbaden, Germany: Springer VS.
- Fouad, N.A. and Bynner, J. (2008) Work transitions. American Psychologist, 63: 4, 241-251.

- Fuller, A. and Unwin, L. (2006) Expansive and Restrictive Learning Environments. In Evans, K., Hodkinson, P., Rainbird, H., Unwin, L., Fuller, A., Hodkinson, H., Kersh, N., Munro, A. and Senker, P. (eds.), *Improving Workplace Learning* (pp. 27-48). Abingdon, UK: Routledge.
- Ecorys UK (2016) *Digital Skills for the UK Economy*. London: Department for Business Innovation and Skills/Department for Culture Media and Sport.
- Eraut, M., Steadman, S., Maillardet, F., Miller, C., Ali, C., Blackman, C., Furner, J. and Caballero, C. (2007) Early career learning at work. Insights into professional development during the first job – TLRP Research Briefing 25. London: TLRP.
- Eurofound (2015) *New forms of employment*. Luxembourg: Publications Office of the European Union.
- Felstead, A., Fuller, A., Unwin, L., Jewson, N., Ashton, D., Bishop, D., Butler, P., Clarke, J., Kakavelakis, K., Khan, A., Lee, T., Shirani, F., Tomlinson, M. and Walters, S. (2008) *Improving working as learning* – TLRP Research Briefing 55. London: TLRP.
- Fouad, N.A. (2007) *Work and Vocational Psychology: Theory, Research, and Applications*. *Annual Review of Psychology*, 58: 1, 543-564.
- Fouad, N.A. and Bynner, J. (2008) Work Transitions. *American Psychologist*, 63: 4, 241-251.
- Frey, C.B. and Osborne, M.A. (2013) *The Future of Employment: How Susceptible Are Jobs To Computerisation?* Oxford: Oxford Martin School, University of Oxford. Available online from: http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf
- Fuller, A. (2007) Mid-life 'transitions' to higher education: developing a multi-level explanation of increasing participation. *Studies in the Education of Adults*, 39: 2, 217-235.
- Fuller, A. and Unwin, L. (2006) Expansive and Restrictive Learning Environments. In Evans, K., Hodkinson, P., Rainbird, H., Unwin, L., Fuller, A., Hodkinson, H., Kersh, N., Munro, A. and Senker, P. (eds.), *Improving Workplace Learning* (pp. 27-48). Abingdon, UK: Routledge.
- Glastra, F.J., Hake, B.J. and Schedler, P.E. (2004) Lifelong Learning as Transitional Learning. *Adult Education Quarterly*, 54, 291-307.
- Green, F., Parsons, S., Sullivan, A. and Wiggins, R. (2015) *Dreaming big: Self-evaluations, aspirations, high-valued social networks, and the private-school earnings premium* (Working Paper 2015/9). London: Centre for Learning and Life Chances in Knowledge Economies and Societies (LLAKES), Institute of Education, University College London.
- Haunberger, S. and Teubner, M. (2008) Bildungswünsche von Eltern und Kindern im Vergleich. Eine empirische Analyse anhand der drei Wellen des DJI-Kinderpanels. In Alt, C. (ed.), *Kinderleben – Individuelle Entwicklungen in sozialen Kontexten* (pp. 293-316). Wiesbaden, Germany: Springer VS.

Heckman, J.J., Stixrud, J. and Urza, S. (2006) The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior (NBER Working Paper no.12006). Cambridge, MA, USA: National Bureau of Economic Research.

Holland, J.L. (1992) Making Vocational Choices: A theory of vocational personalities and work environments. Odessa, Florida: Psychological Assessment Resources.

Hughes, D., Adriaanse, K. and Barnes, S-A. (2016) Adult Education. Too important to be left to chance (A report commissioned by the All Party Parliamentary Group for Adult Education (APPG). London: APPG.

Huws, U. (2015). A review on the future of work: online labour exchanges, or 'crowdsourcing': implications for occupational safety and health. Bilbao, Spain: European Agency for Safety and Health at Work, European Union.

Krumboltz, J.D. and Nichols, C.W. (1990) Integrating the Social Learning Theory of Career Decision Making. In Walsh, W.B. and Osipow, S.H. (eds). Career Counseling: Contemporary Topics in Vocational Psychology (pp.159-192). New Jersey, USA: Lawrence Erlbaum Associates Inc.

London, M. and Noe, R.A. (1997) London's Career Motivation Theory: An Update on Measurement and Research. Journal of Career Assessment, 5: 1, 61-80.

Loretto, W., Phillipson, C. and Vickerstaff, S. (2016, forthcoming) Skills and training for the older population: Training the new work generation. In Warhurst, C., Mayhew, K., Finegold, D. and Buchanan, J. (eds). Oxford Handbook of Skills and Training. Oxford: Oxford University Press.

Macrory, I. (2016) Measuring national well-being: Life in the UK: 2016. Newport: Office for National Statistics.

McMahon, M., Watson, M. and Bimrose, J. (2012) Career adaptability: A qualitative understanding from the stories of older women. Journal of Vocational Behavior, 80: 3, 762-768.

McQuaid, R.W. and Lindsay, C. (2005) The concept of employability. Urban Studies 42, 197-219.

Mitchell, L.K. and Krumboltz, J.D. (1996) Krumboltz's learning theory of career choice and counseling. In Brown, D., Brooks, L. and Associates (eds.) Career choice and development (3rd edition, pp. 223-280). San Francisco, CA: Jossey-Bass.

Morrison Gutman, L. and Schoon, I. (2013) The impact of non-cognitive skills on outcomes for young people: Literature review. London: The Education Endowment Foundation.

OECD (2015a) Adults, Computers and Problem Solving: What's the Problem? OECD Skills Studies. Paris: OECD.

OECD (2015b) How is the global talent pool changing (2013, 2030)?, Education Indicators in Focus 31. Paris: OECD.

OECD (2016a) Trends Shaping Education 2016. Paris: OECD.

OECD (2016b) Skills Matter: Further Results from the Survey of Adult Skills. OECD Skills Studies. Paris: OECD.

OECD (2016c) OECD Employment Outlook 2016. Paris: OECD.

Osipow, S.H. and Fitzgerald, L.F. (1996) Theories of Career Development (4th Edition). Needham Heights, Massachusetts: Allyn & Bacon.

Paccagnella, M. (2016) Age, ageing and skills: Results from the Survey of Adult Skills. OECD Education Working Papers, No. 132. Paris: OECD.

Patton, W. and McMahon, M.L. (2014) Career development and systems theory: Connecting theory and practice. Rotterdam: Sense.

Peterson, G.W., Sampson, J.P., Lenz, J.G. and Reardon, R.C. (2002) Becoming career problem solvers and decision makers: A cognitive information processing approach. In Brown, D. (ed.) Career choice and development (4th edition, pp. 312-369). San Francisco: Jossey-Bass.

Roberts, K. (2007) Opportunity structures then and now. *Journal of Education and Work*, 22: 5, 355-368.

Savickas, M. (2013) Career Construction theory and practice. In Lent, R.W. and Brown, S.D. (eds) Career Development and Counseling: Putting theory and research to work (2nd edition, pp. 147-183). New Jersey: John Wiley.

Savickas, M.L., Nota, L., Rossier, J., Dauwalder, J-P., Duarte, M.E., Guichard, J., et al. (2009) Life designing: A paradigm for career construction in the 21st century. *Journal of Vocational Behavior*, 75: 3, 239-250.

Savickas, M.L. (1997) Career adaptability: An integrative construct for life-span, life-space theory. *Career Development Quarterly*, 45: 3, 247-259.

Savickas, M.L. and Porfeli, E.J. (2012) Career Adapt-Abilities Scale: Construction, reliability and measurement equivalence across 13 countries. *Journal of Vocational Behaviour*, 80, 661-673.

Schmid, G. (2016, forthcoming) A working lifetime of skill and training needs. In Warhurst, C., Mayhew, K., Finegold, D. and Buchanan, J. (eds). *Oxford Handbook of Skills and Training*. Oxford: Oxford University Press.

Schultheiss, D. (2003) A relational approach to career counseling. Theoretical integration and practical application. *Journal of Counseling and Development*, 81, 301–310.

Störmer, E., Patscha, C., Prendergast, J., Daheim, C., Rhisiart, M., Glover, P. and Beck, H. (2014) The Future of Work Jobs and Skills in 2030. Wath upon Dearne: UK Commission for Employment and Skills.

Super, D.E. (1957) The psychology of careers: An introduction to vocational development. New York: HarperCollins.

Tholen, G., James Relly, S., Warhurst, C. and Commander, J. (2016) Higher education, graduate skills and the skills of graduates: The case of graduates as residential sales estate agents. *British Educational Research Journal*, 42: 3, 508-523.

van Deursen, A. and van Dijk, J. (2010) Internet skills and the digital divide. *New Media & Society*, 13:6, 893-911.

Warhurst, C., Mathieu, C. and Wright, (2016) Innovation, job quality and wellbeing at work in an age of disruption: The case of Uberisation. In Rok, B. and Struminska-Kutra, M. (eds) *Workplace Innovation. Between Efficiency and the Quality of Working Life*. Warsaw: Poltex.

Wilson, R., Sofroniou, N., Beaven, R., May-Gillings, M., Perkins, S., Lee, M., Glover, O., Limmer, H. and Leach, A. (2016) *Working Futures 2014-2024*. Wath upon Dearne: UK Commission for Employment and Skills.

Yeager, D.S. and Dweck, C.S. (2012) Mindsets that promote resilience: when students believe that personal characteristics can be developed. *Educational Psychologist* 47: 4, 302-314.

Zacher, J. (2014) Individual difference predictors of change in career adaptability. *Journal of Vocational Behavior*, 84: 2, 188-198.

Acknowledgments

The authors would like to thank reviewers who provided helpful and constructive comments on an earlier draft of this paper.



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